Dynamic population modeling (DPM) is a useful approach to assess the potential population health effects of a new product introduction when epidemiological data are not available.

DPM allows impact assessment of product initiation, switching, dual use, and cessation on future <u>prevalence and mortality</u> for a specific population.
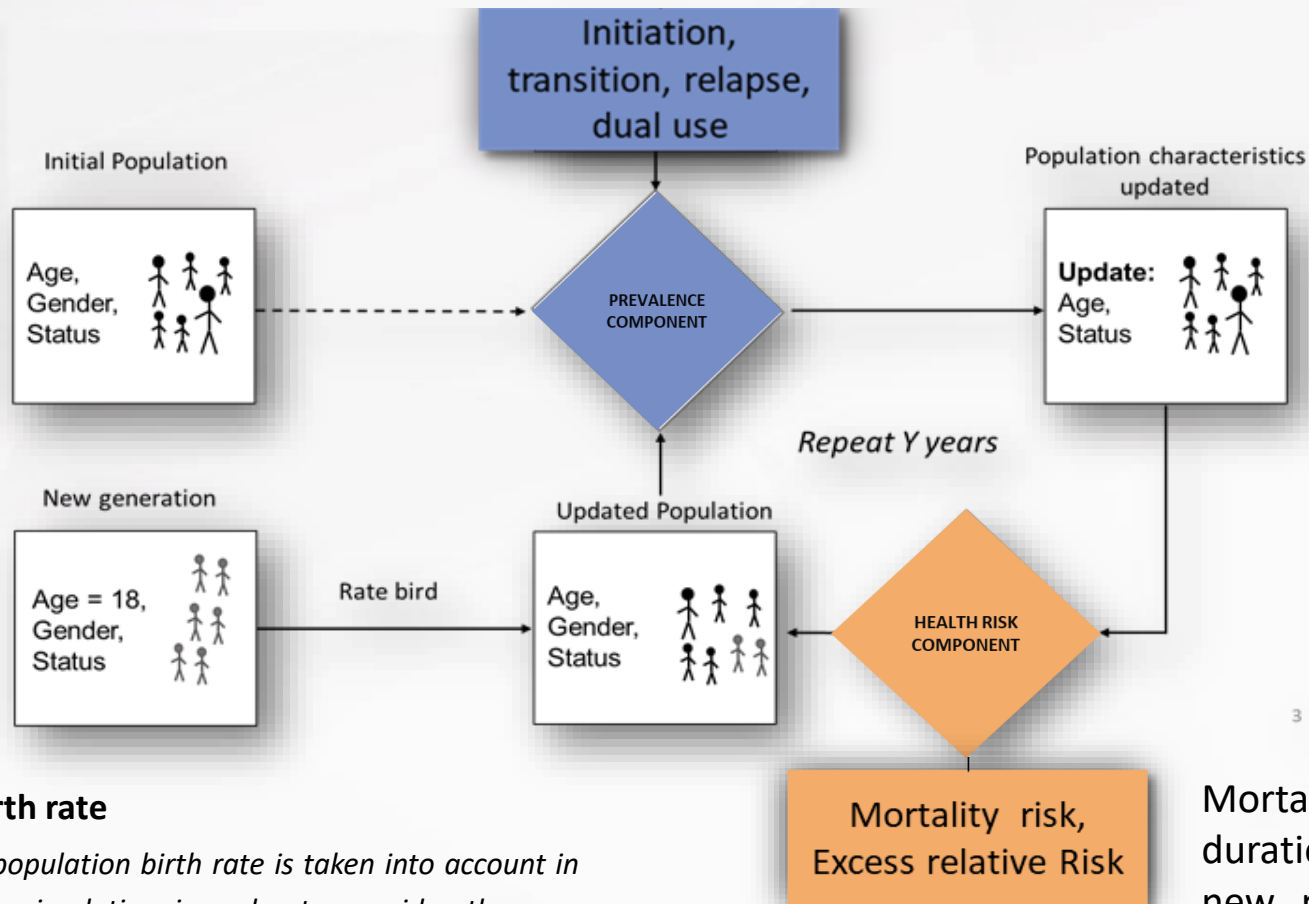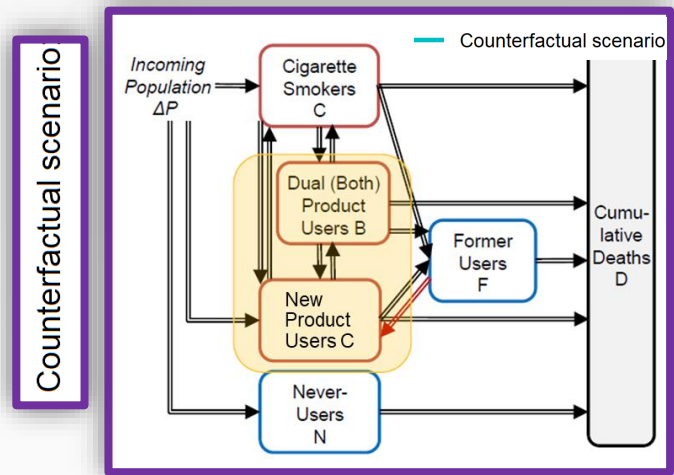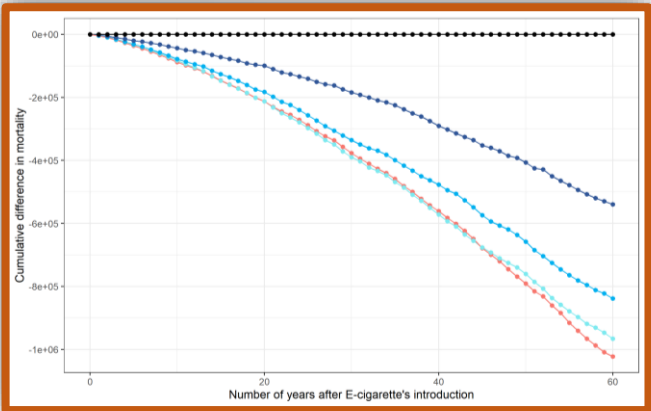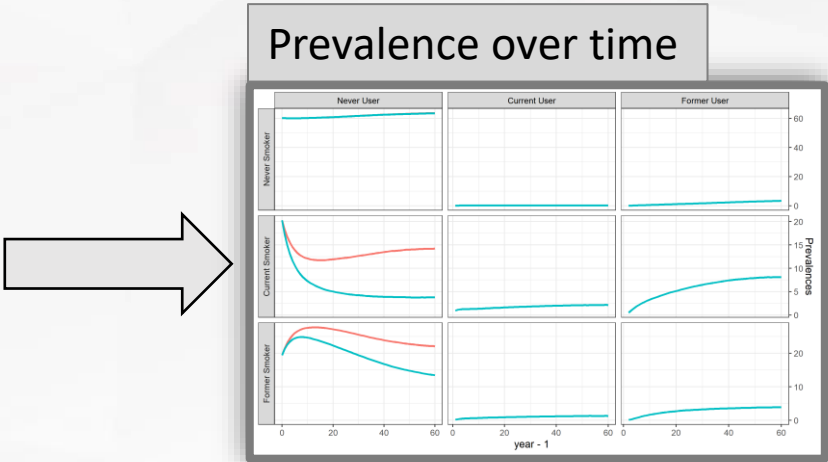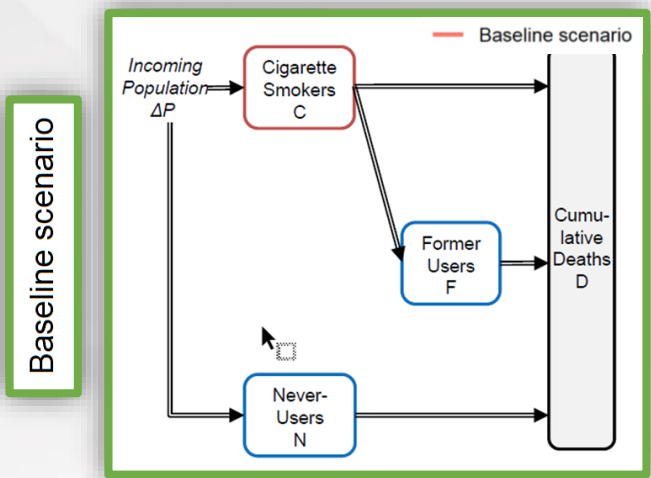
Birth rate

A population birth rate is taken into account in the simulation in order to consider the new generations over a long period of time.

Mortality calculated for each age interval - based on age, duration of smoking, and duration of quit; mortality rates for new product users based on excess relative risk (ERR) estimate, relative to smoking

How to predict the likely impact of a **new product category on population health?**

By comparing smoking prevalence and mortality risk associated in a
baseline scenario and a counterfactual scenario

Baseline scenario

Counterfactual scenario

Prevalence over time

Mortality over time

Transition matrix

Relative Risk

0.05	A reduction in risk of 95% compared to smoking
0.10	A reduction in risk of 90% compared to smoking
0.20	A reduction in risk of 80% compared to smoking
0.50	A reduction in risk of 50% compared to smoking

Transition matrix

A transition matrix contains the probability to change from one status to another one (initiate, relapse, stop, stay or switch)

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
N_N	P1	P2		P3	P4				
N_C		P5	P6		P7	P8			
N_F		P9	P10		P11	P12			
C_N				P13	P14		P15	P16	
C_C					P17	P18		P19	P20
C_F					P21	P22		P23	P24
F_N				P25	P26		P27	P28	
F_C					P29	P30		P31	P32
F_F					P33	P34		P35	P36

- Initiation
- Relapse
- Cessation
- Stabilisation
- Switch

A transition matrix depends on demographic parameters such age, gender…

9 status / 4 transitions per status
=
**36 transition probabilities per matrix**

Transition matrix

➤ Transition probabilities are key inputs for population models to determine the net population health impact of introducing a new tobacco product into a market

➤ In recent years, several publications have discussed the use of computational models to assess the overall population level impact of e-cigarettes in terms of changes in smoking prevalence, all-cause mortality, smoking-related mortality, etc.

➤ However, transition probabilities regarding product switching, initiation and cessation were often **assumed** in these published computational models.

➤ In order to project the long-term impact of a new product use on the US population, **transition probabilities representative of the US population are needed to replace assumptions** when developing population models.

➤ Only **longitudinal survey data provide accurate transition patterns** among adult cigarette smokers, new product users, and dual users by taking into account cigarette smoking and new product use histories and experimental or established use behaviors.

Transition matrix

To develop transitional patterns among different groups of cigarette and/or e-cigarette users, we used the longitudinal data **from wave 2 to wave 3 in the PATH public** use data files
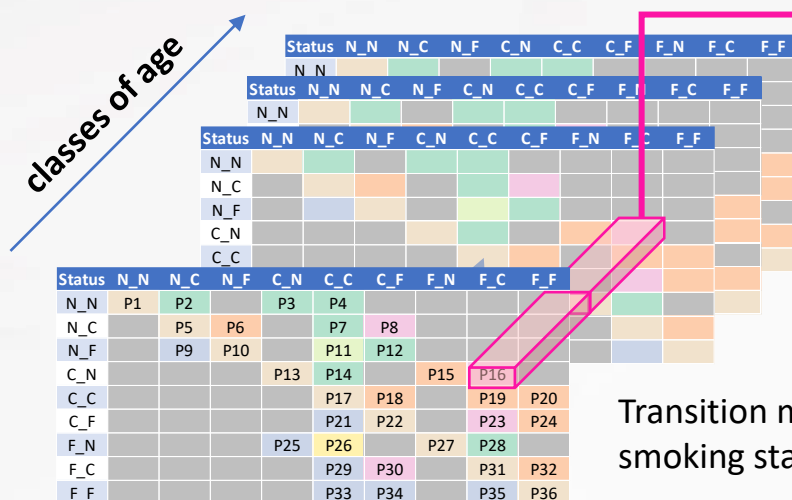
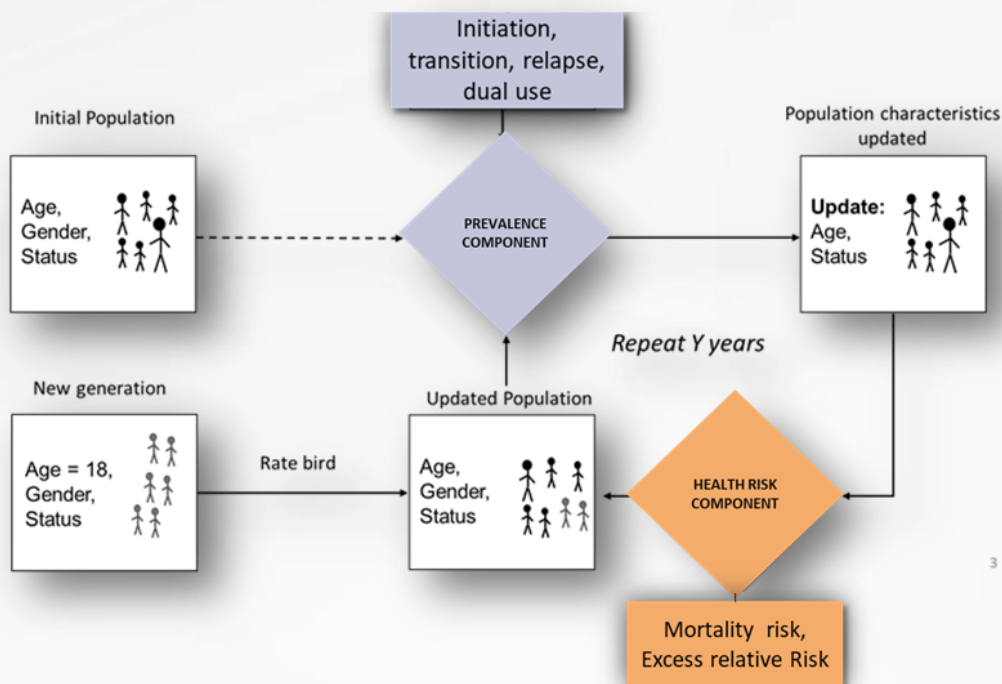Transition matrix according to smoking status and class of ages
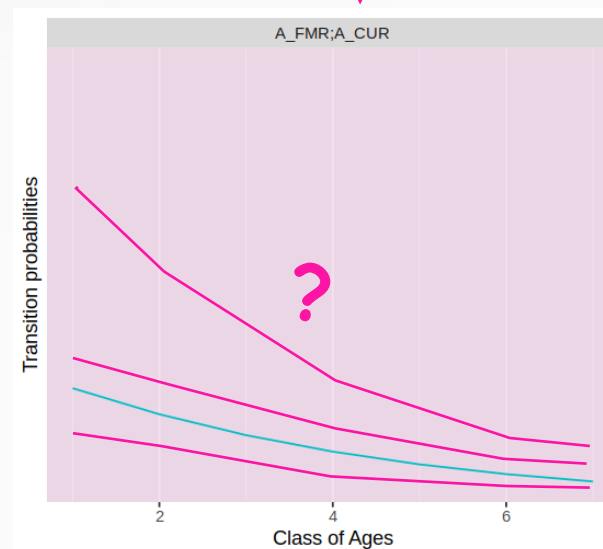
How to update these transitions for a new e-cigarette not yet available on the market?
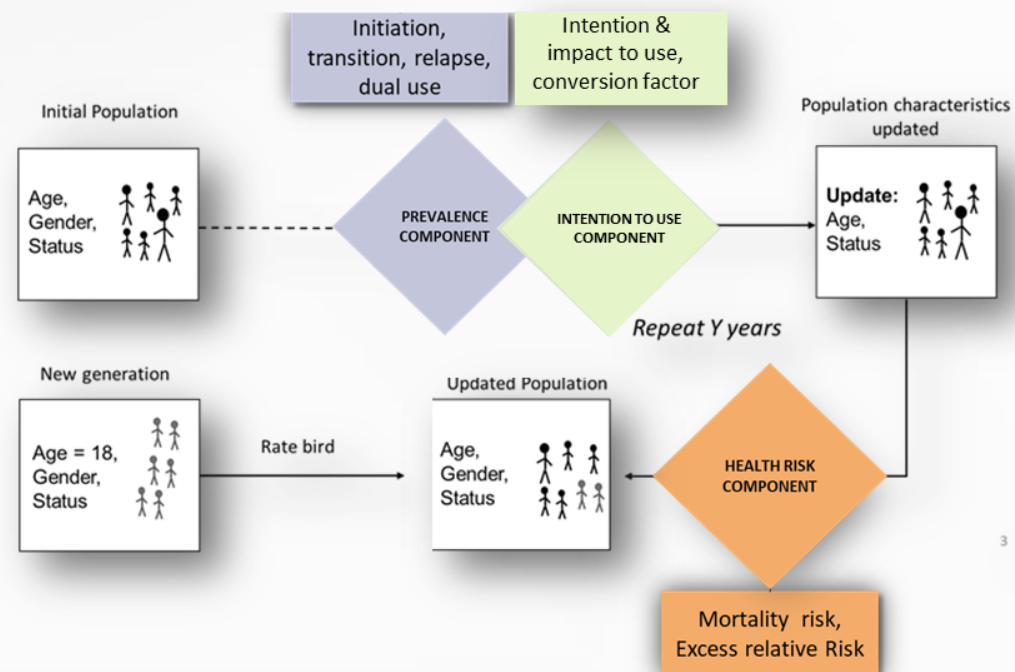
New transition matrix

PREVALENCE COMPONENT

PATH Study
Transition Matrix for e-cigs

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
N_N	P1	P2		P3	P4				
N_C		P5	P6		P7	P8			
N_F		P9	P10		P11	P12			
C_N				P13	P14		P15	P16	
C_C					P17	P18		P19	P20
C_F					P21	P22		P23	P24
F_N				P25	P26		P27	P28	
F_C					P29	P30		P31	P32
F_F					P33	P34		P35	P36

Intention to use Study
I2U Matrix for the new e-cig

×

Transition matrix for e-cigs + the new e-cig

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
N_N	P1*	P2*		P3*	P4*				
N_C		P5*	P6*		P7*	P8*			
N_F		P9*	P10*		P11*	P12*			
C_N				P13*	P14*		P15*	P16*	
C_C					P17*	P18*		P19*	P20*
C_F					P21*	P22*		P23*	P24*
F_N				P25*	P26*		P27*	P28*	
F_C					P29*	P30*		P31*	P32*
F_F					P33*	P34*		P35*	P36*

Intension to use
"ITU score" is the proportion of person having the **intention to use** the new e-cigarettes according their status.

Conversion factor
λ is the probability at which a person **performs the action of using** the product.

Impact to use
Impact to use is **the sign** of the impact of the intention to use the new-cigarette on the transition probabilities
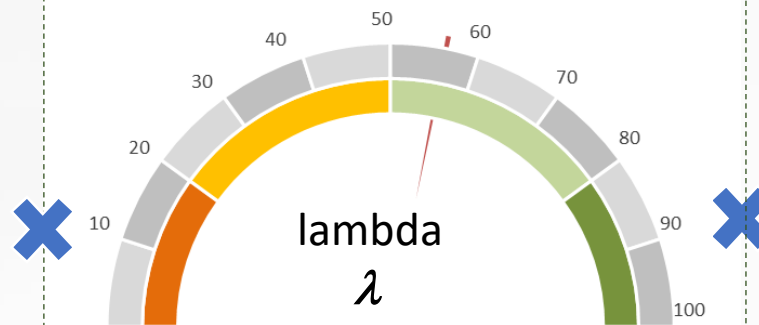
Transition matrices updated for a new e-cigarette

PREVALENCE COMPONENT

Intension to use

"ITU score" is the proportion of people having the **intention to use** the new e-cigarettes according their status.

Status	ITU
N_N	0.0%
N_C	2.5%
N_F	0.0%
C_N	5.0%
C_C	2.5%
C_F	5.0%
F_N	0.0%
F_C	2.5%
F_F	0.0%

Conversion factor

λ is the probability at which a person **performs the action of using** the product.

lambda
λ

Impact to use

Impact to use is **the sign** of the intention to use the new-cigarette on the transition probabilities

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
N_N	-	+							
N_C		+	-		-	-			
N_F		+	-			-			
C_N				-				+	
C_C				-		-		+	
C_F				-		-		+	
F_N				-	-			+	
F_C				-		-		+	
F_F				-		-		+	

Note: *The intensity of the modification of transition will be proportional to the current transition probability among all the transition impacted in the same direction. Higher is the current transition higher will be the impact. The modification will be ranged from 0 (no intention to use) to λ x ITU score.*

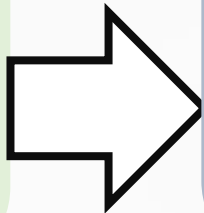# Example of transition matrices updated for a new e-cigarette

PREVALENCE COMPONENT

PATH Study
Transition Matrix for e-cigs

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				73.3%	6.4%		18.9%	1.4%	

Intention to use Study
I2U Matrix for the new e-cig

Transition Matrix for e-cigs + the new e-cig

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				69.3%	6.4%		18.9%	5.4%	

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				69.3%	9.6%		18.9%	2.2%	

Intension to use

Status	I2U
C_N	5.0%

Conversion factor

$\lambda = 80\%$
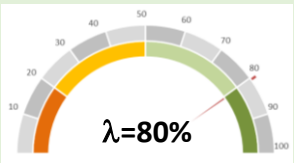
Impact to use

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				-				+	

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				-	+			+	

Example of transition matrices updated for a new e-cigarette

New-e-cigarette ITU score for Smoker ; Never ENDS user

Status	I2U
C_N	5.0%

And with a conversion factor   λ=80%

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				73.3%	6.4%		18.9%	1.4%	

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				69.3%	6.4%		18.9%	5.4%	

Impact sign of UTI score on transition matrix for C_C

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
C_N				-				+	
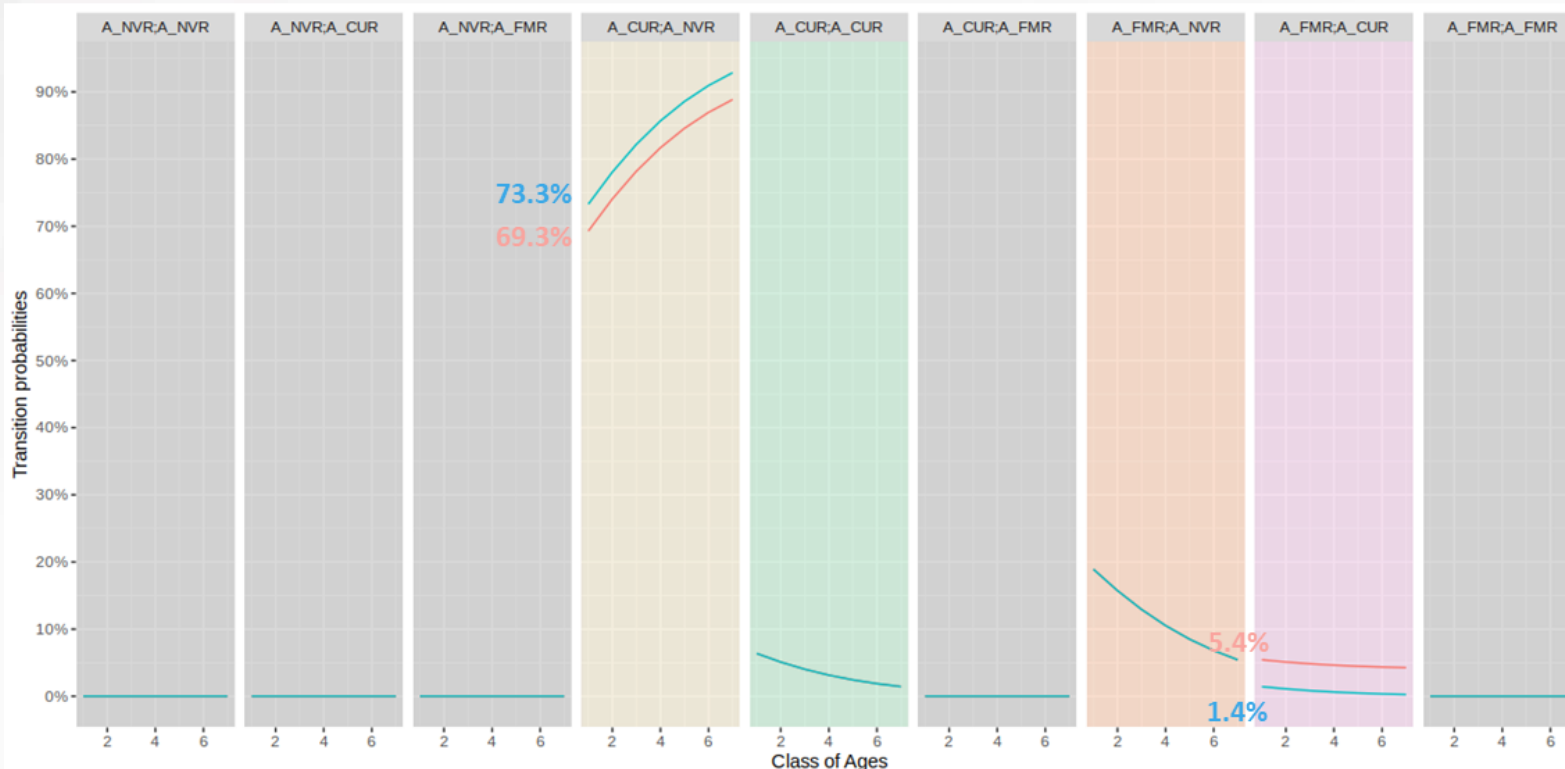
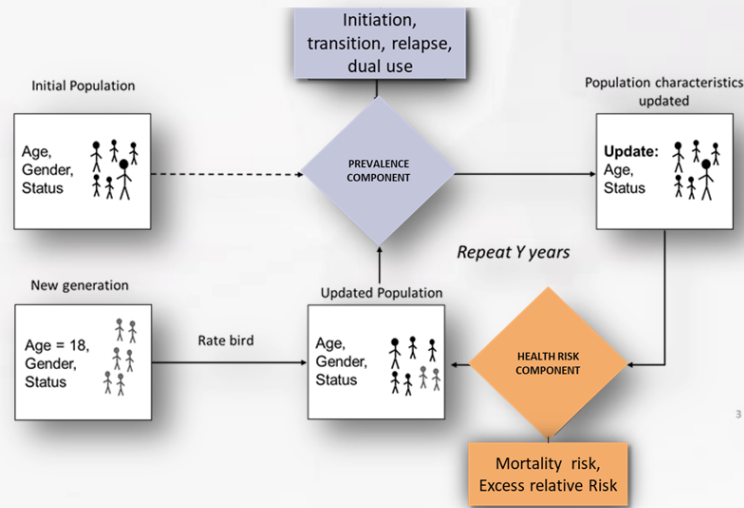**Current Prevalence**

Updated Prevalence with ITU

PREVALENCE COMPONENT

Example: Transition matrices updated for a new e-cigarette
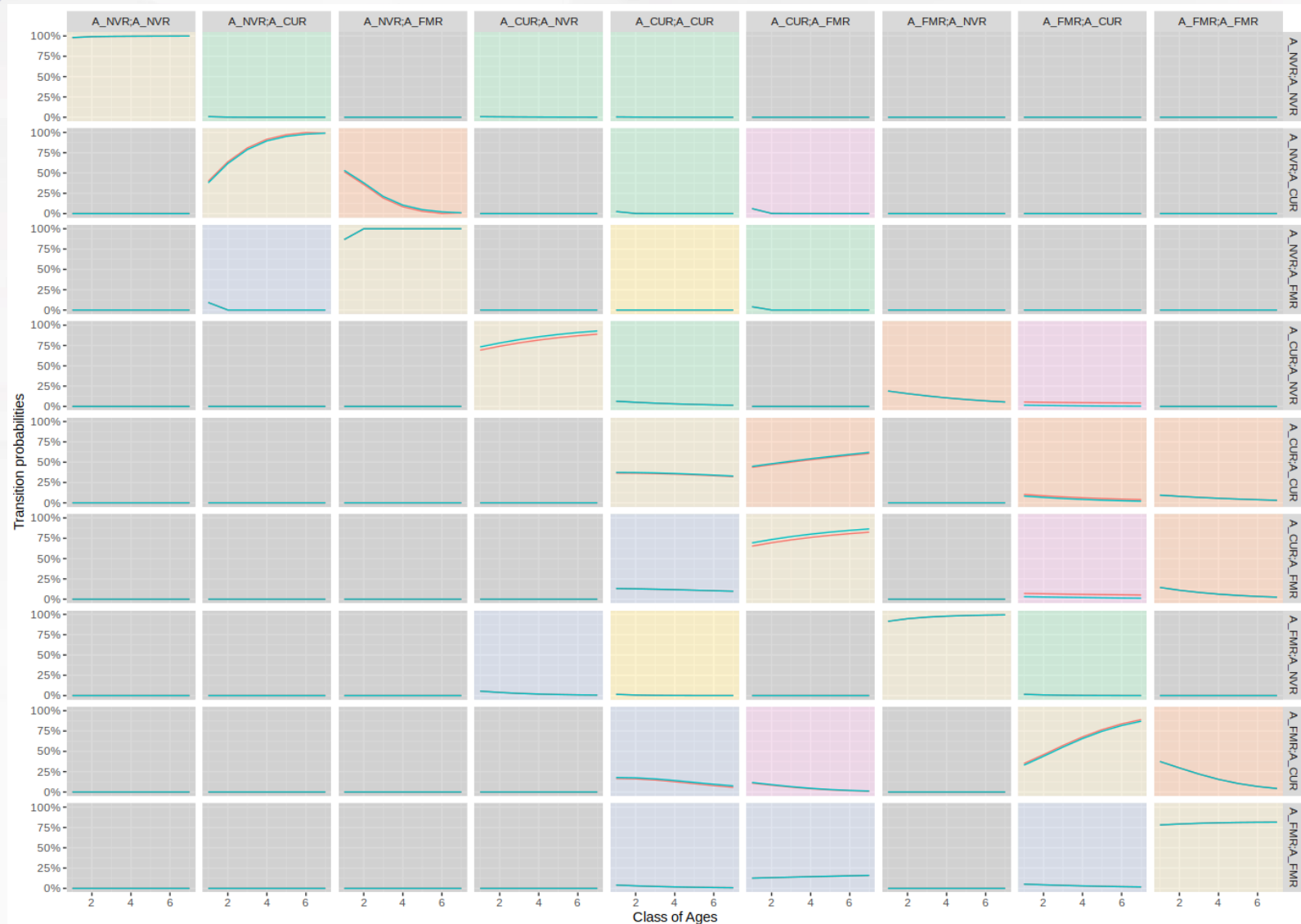
Current Prevalence
Updated Prevalence

DPM for a new e-cigarette

Example of results of three scenarios

Status	ITU
N_N	0.0%
N_C	2.5%
N_F	0.0%
C_N	5.0%
C_C	2.5%
C_F	5.0%
F_N	0.0%
F_C	2.5%
F_F	0.0%

LOW

Err =5 %

λ=80%

Status	N_N	N_C	N_F	C_N	C_C	C_F	F_N	F_C	F_F
N_N	-	+							
N_C		+	-		-	-			
N_F		+	-						
C_N				-				+	
C_C					-	-		+	
C_F						-		+	
F_N				-			-	+	
F_C					-	-		+	
F_F					-	-		+	

1 Base case (total death: 42,702,323)
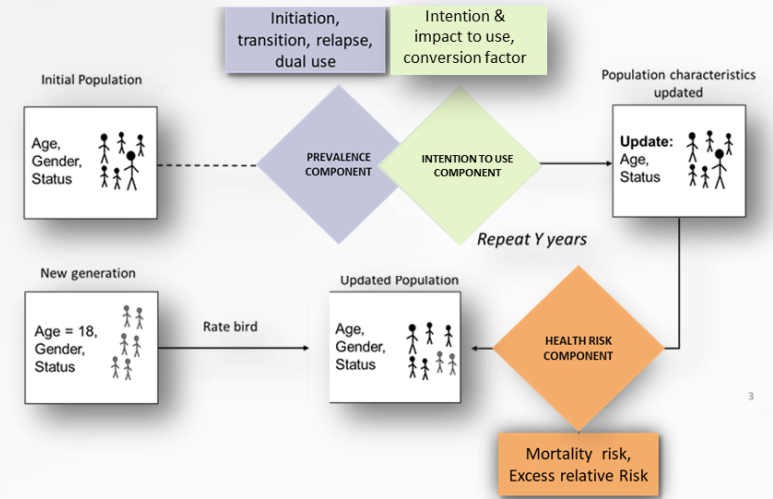
2 Counterfactual case

    - 664,933 (-1.56%)

3 Counterfactual + New product

    - 908,997 (-2.13%)

Cumulative difference mortality

Number of year after new product introduction
(Reference US population in 2000: 283,000,000)

Conclusions

- **Dynamic population modelling (DPM) is a useful approach to assess the potential population health effects of introducing a new tobacco product compared to cigarette** when epidemiological data are not yet available.

- **Transition probabilities are fundamental inputs** to determine the net population health impact of introducing a new tobacco product onto the market

- **For a new e-cigarette**, **no prevalence data** from longitudinal studies are available to compute the new transition matrices in order to assess the potential health impact of new product by DPM.

- In this presentation we have shown how the **intention to use** could be implemented in DPM in order to adjust the transition probabilities for a new e-cigarette, and to evaluate its likely health impact on a population.